

IN THE CLAIMS:

Claims 1-3 (Previously Cancelled)

Claims 4-10 (Currently Cancelled)

11. (Currently Amended) An optical signal reading method for converting an optical signal into an electric signal, converting the electric signal into a digital signal, and then outputting the digital signal, wherein

a plurality of the photoelectric conversion devices are arrayed in rows and columns, each of the photoelectric conversion devices including

(i) a photodetector, and

(ii) an insulated gate field effect transistor for optical signal detection provided adjacent to the photo detector, the insulated gate field effect transistor for optical signal detection including a heavily doped buried layer for storing photo-generated charges generated by the photo detector, the heavily doped buried layer being provided around a source region under a channel region below a gate electrode; and

a variable gain amplifier is provided in each of the columns, the variable gain amplifier including

(iii) an input terminal for sequentially inputting a first signal voltage and a second signal voltage,

(iv) an output terminal for outputting a difference signal between the first signal

voltage and the second signal voltage,

(v) an operational amplifier having a positive input for inputting a reference voltage, a negative input, and an output connected to the output terminal,

(vi) an input capacitor provided in a signal path extending from the input terminal to the negative input of the operational amplifier, the input capacitor having one end connected through the signal path to the input terminal and having the other end connected through the signal path to the negative input of the operational amplifier,

(vii) a feedback capacitor provided between the negative input and the output of the operational amplifier,

(viii) a first switch device for connecting/disconnecting a signal path extending from the input terminal to the one end of the input capacitor,

(ix) a second switch device for connecting/disconnecting the reference voltage to the one end of the input capacitor, and

(x) a third switch device for connecting/disconnecting the negative input and the output of the operational amplifier;

the optical signal reading method comprises the steps of:

(a) irradiating each photodetector with an optical signal;

(b) transferring photo-generated charges generated by the photodetector and storing them in the heavily doped buried layer of the insulated gate field effect transistor for optical signal detection, while connecting the second and third switch devices to initialize the input capacitor and the feedback capacitor;

(c) then, connecting the first and third switch devices, disconnecting the second switch

device, outputting a signal voltage according to the photo-generated charges stored in the heavily doped buried layer from the insulated gate field effect transistor for optical signal detection, and then converting the signal voltage into charges and storing them in the input capacitor as the first signal voltage;

(d) then, connecting the second switch device and disconnecting the third switch device, so as to transfer the charges of the first signal voltage stored in the input capacitor to the feedback capacitor;

(e) then, discharging the photo-generated charges remaining in the heavily doped buried layer to initialize the photoelectric conversion device, thereafter connecting the first switch device, disconnecting the second and third switch devices, outputting a second signal voltage in the initialized state of the photoelectric conversion device from the insulated gate field effect transistor ~~as the second signal voltage~~ for optical signal detection, then converting the second signal voltage into charges, and storing a difference between the charges of the first signal voltage and the charges of the second signal voltage to generate the difference signal;

(f) converting the difference signal into a digital signal; and

(g) then, adjusting a gain by adjusting a ratio of the input capacitor and the feedback capacitor so as to set the difference signal within a range of an analog input voltage which is converted into the digital signal, and outputting the difference signal having the output level adjusted from the operational amplifier to each of the columns.

Claims 12-16 (Currently Cancelled)

17. (Previously Amended) An optical signal reading method of a solid-state imaging device which includes a plurality of photoelectric conversion devices arrayed in rows and columns for converting an optical signal into an electric signal and for outputting the electric signal, a plurality of amplifiers provided for the respective columns, each of the amplifiers for sequentially inputting a first signal voltage obtained by converting the optical signal into the electric signal, and a second signal voltage obtained by initializing the photoelectric conversion device, for converting the first signal voltage and the second signal voltage into charges, and for outputting a difference signal therebetween, and a video signal output terminal for outputting the difference signal outputted from the amplifier as a video signal corresponding to the optical signal, wherein

each of the photoelectric conversion devices includes

(i) a photodetector, and

(ii) an insulated gate field effect transistor for optical signal detection, provided adjacently to the photodetector, the insulated gate field effect transistor for optical signal detection including a heavily doped buried layer for storing photo-generated charges generated by the photo detector, the heavily doped buried layer being provided around a source region under a channel region below a gate electrode, the first signal voltage and the second signal voltage are outputted from the source region of the insulated gate field effect transistor for optical signal detection; each amplifier including

(iii) an input terminal for sequentially inputting the first signal voltage and the second signal voltage,

(iv) an output terminal for outputting a difference signal between the first signal

voltage and the second signal voltage,

(v) an operational amplifier having a positive input for inputting a reference voltage, a negative input and an output connected to an output terminal of the amplifier,

(vi) an input capacitor provided in a signal path extending from the input terminal of the amplifier to the negative input of the operational amplifier, the input capacitor having one end connected through the signal path to the input terminal of the amplifier and having the other end connected through the signal path to the negative input of the operational amplifier,

(vii) a feedback capacitor provided between the negative input and the output of the operational amplifier,

(viii) a first switch device for connecting/disconnecting the signal path,

(ix) a second switch device for connecting/disconnecting the reference voltage to the one end of the input capacitor, and

(x) a third switch device for connecting/disconnecting the negative input and the output of the operational amplifier, and

a pixel mixing switch device connecting the negative inputs of the operational amplifiers of at least two columns,

the method comprises the steps of

(a) irradiating each photodetector with an optical signal;

(b) transferring photo-generated charges generated by the photo detector to the heavily doped buried layer of the insulated gate field effect transistor for optical signal detection and storing the charges therein, while connecting the second and third switch devices to initialize the

input capacitor and the feedback capacitor;

(c) then, connecting the first and third switch devices, disconnecting the second switch device and the pixel mixing switch device, and thus outputting the first signal voltage corresponding to the photo-generated charges stored in the heavily doped buried layer from the insulated gate field effect transistor for optical signal detection, and converting the first signal voltage into charges and storing the charges in the input capacitor;

(d) then, connecting the second switch device, disconnecting the third switch device, and thus transferring the charges of the first signal voltage stored in the input capacitor to the feedback capacitor; and

(e) then, discharging the photo-generated charge remaining in the heavily doped buried layer to initialize the photoelectric conversion device, thereafter connecting the first switch device and the pixel mixing switch device, disconnecting the second and third switch devices, outputting a second signal voltage in the initialized state of the photoelectric conversion device from the insulated gate field effect transistor for optical signal detection, thus converting the second signal voltage into charges and storing them in the input capacitor, then mixing the charges of the first signal voltages from the photoelectric conversion devices of at least two columns and the charges of the second signal voltage therefrom through the pixel mixing switch device connecting the negative input terminals of the operational amplifiers of the at least two columns, and then outputting an output signal from the operational amplifier.